Sandia National Laboratories
Waste Isolation Pilot Plant (WIPP)

Testing of Wells at the WIPP Site
Test Plan TP 03-01, Rev. 0

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FIGURES

1 ABBREVIATIONS, ACRONYMS, AND INITIALISMS

A	ampere
APV	access port valve
CBFO	(U.S. DOE) Carlsbad Field Office
CMR	Central Monitoring Room
DAS	data-acquisition system
DC	direct current
DOE	(U.S.) Department of Energy
DST	drill-stem test
EPA	(U.S.) Environmental Protection Agency
ES&H	environmental safety and health
FY	fiscal year
gal	gallons
GET	General Employee Training
gpm	gallons per minute
GWMP	Groundwater Monitoring Program
HA	hazard analysis
I.D.	inside diameter
JHA	job hazard analysis
mA	milliamp
NMOSE	New Mexico Office of the State Engineer
n	flow dimension
NP	(SNL NWMP) Nuclear Waste Management (QA) Procedure
NWMP	Nuclear Waste Management Program
PHS	primary hazard screening
PI	Principal Investigator
PIP	production injection packer
psia	pounds per square inch absolute
psig	pounds per square inch gauge
QA	quality assurance
QAPD	Quality Assurance Program Document
S	storativity
SNL	Sandia National Laboratories
SP	(SNL NWMP) Activity/Project-Specific Procedure
T	transmissivity
TOP	(SNL NWMP) Technical Operating Procedure
TP	(SNL) test plan
WRES	Washington Regulatory and Environmental Services
WIPP	(U.S. DOE) Waste Isolation Pilot Plant
WTL	(SNL) Well Testing Lead

2 REVISION HISTORY

This is the original edition of this test plan (TP); no prior versions exist. The purpose and content of any future changes and/or revisions will be documented and appear in this section of revised editions. Changes to this TP, other than those defined as editorial changes per Nuclear Waste Management Program (NWMP) quality assurance (QA) procedure NP 20-1 (Subsection 4.6.4), shall be reviewed and approved by the same organization that performed the original review and approval. All TP revisions will have at least the same distribution as the original document.

3 PURPOSE AND SCOPE

The Waste Isolation Pilot Plant (WIPP) is a U.S. Department of Energy (DOE) facility designed for the safe disposal of transuranic wastes resulting from U.S. defense programs. In order to demonstrate compliance with U.S. EPA (1993) and U.S. EPA (1996), models of groundwater flow around the WIPP are needed. These models must:

- demonstrate that an understanding of the hydrologic system within which WIPP exists,
- identify the flowpaths that radionuclides released from the WIPP repository through inadvertent human intrusion would most likely take, and
- simulate groundwater flow and radionuclide transport along the important flowpaths in the event that human intrusion of the repository occurs.

Development of these models requires data from wells completed to all units within the hydrologic system. Some of the data for modeling come from tests (including sampling) performed in these wells. These data include:

- hydraulic parameters, e.g., flow dimension (n), storativity (S), and transmissivity (T), inferred from well tests used to define parameter distributions within the models;
- transient head responses from observation wells during long-term pumping tests that can be used during model calibration to infer hydraulic properties in areas where no wells may exist;
- direct measurements of the rates and directions of groundwater flow through wells that can be used in model verification;
- fluid specific gravities (or densities) used in calculation of hydraulic head gradients; and
- water-quality analyses that may be useful in inferring flow directions and fluid sources.

This TP describes the methods that will be used to obtain the data needed for hydrologic modeling at the WIPP.

4 EXPERIMENTAL PROCESS RATIONALE AND DESCRIPTION

The wells to be tested include both existing wells and new wells to be drilled in FY 2003 and later years. New wells are expected to be completed to the Culebra Member and the Magenta Member (both of these are members of the Rustler Formation), and to the Dewey Lake Fm. and the Santa Rosa Fm. (Figure 4-1). The existing wells to be tested are C-2737, WIPP-25, and WIPP-26 (Figure 4-2). These three wells are all completed to both the Culebra and Magenta (the Magenta is unsaturated at WIPP-26). Both the Culebra and Magenta need to be tested in C-2737, but only the Culebra needs to be tested in WIPP-25 and WIPP-26. All new wells will be completed in single horizons.

Well C-2737 was drilled and completed in 2001 as a replacement for H-1 and has never been tested. Although testing of the Culebra was performed in WIPP-25 and WIPP-26 in 1980 (Lambert and Robinson, 1984), no documentation of that testing is available. Hence, the Culebra needs to be retested in those wells to provide data that can be used in modeling. Current configurations of these wells are shown in Figures 4-3 through 4-5.

Twelve new Culebra wells (Figure 4-2) have been proposed to provide data needed for modeling and to resolve questions about observed water-level fluctuations. At least four of these wells are planned to be drilled in FY 2003 to investigate leakage from a potash tailings pile 7 miles to the north of the WIPP Site and to determine if dissolution of the upper Salado Fm. has occurred and affected the Culebra in specific areas. Preliminary designations of these wells are Sandia National Laboratories-1 (SNL-1, near the tailings pile), SNL-2, SNL-3, and SNL-9. These designations will be replaced with C-#### designations reflecting the permit numbers assigned by the New Mexico Office of the State Engineer (NMOSE) once those permits have been obtained. Although not discussed in this TP, Magenta and/or Dewey-Lake wells may also be installed at some of these locations. Additional wells may also be drilled in future years to supplement the existing monitoring well network, or to replace existing monitoring wells that have deteriorated so badly that they must be plugged and abandoned. Testing will be required in all new wells.

System	Series	Group	Formation	Member	Approximate Thickness* (m)	(ft)
Quaternary	Recent		Surficial Deposits		3	10
	Pleistocene		Mescalero Caliche		10	30
			Gatuña			
Triassic		Dockum	Santa Rosa		3	10
Permian	Ochoan		Dewey Lake Redbeds		150	500
			Rustler	Forty-niner	18	60
				Magenta	7	24
				Tamarisk	26	85
				Culebra Dolomite	7	24
				Los Medaños	37	120
			Salado		600	2000
			Castile		400	1300
	Guadalupian	Delaware Mountain	Bell Canyon		310	1000
			Cherry Canyon		335	1100
			Brushy Canyon		550	1800

* At center of WIPP site.

TRI-6115-36-4

Figure 4-1. Stratigraphic units at the WIPP Site

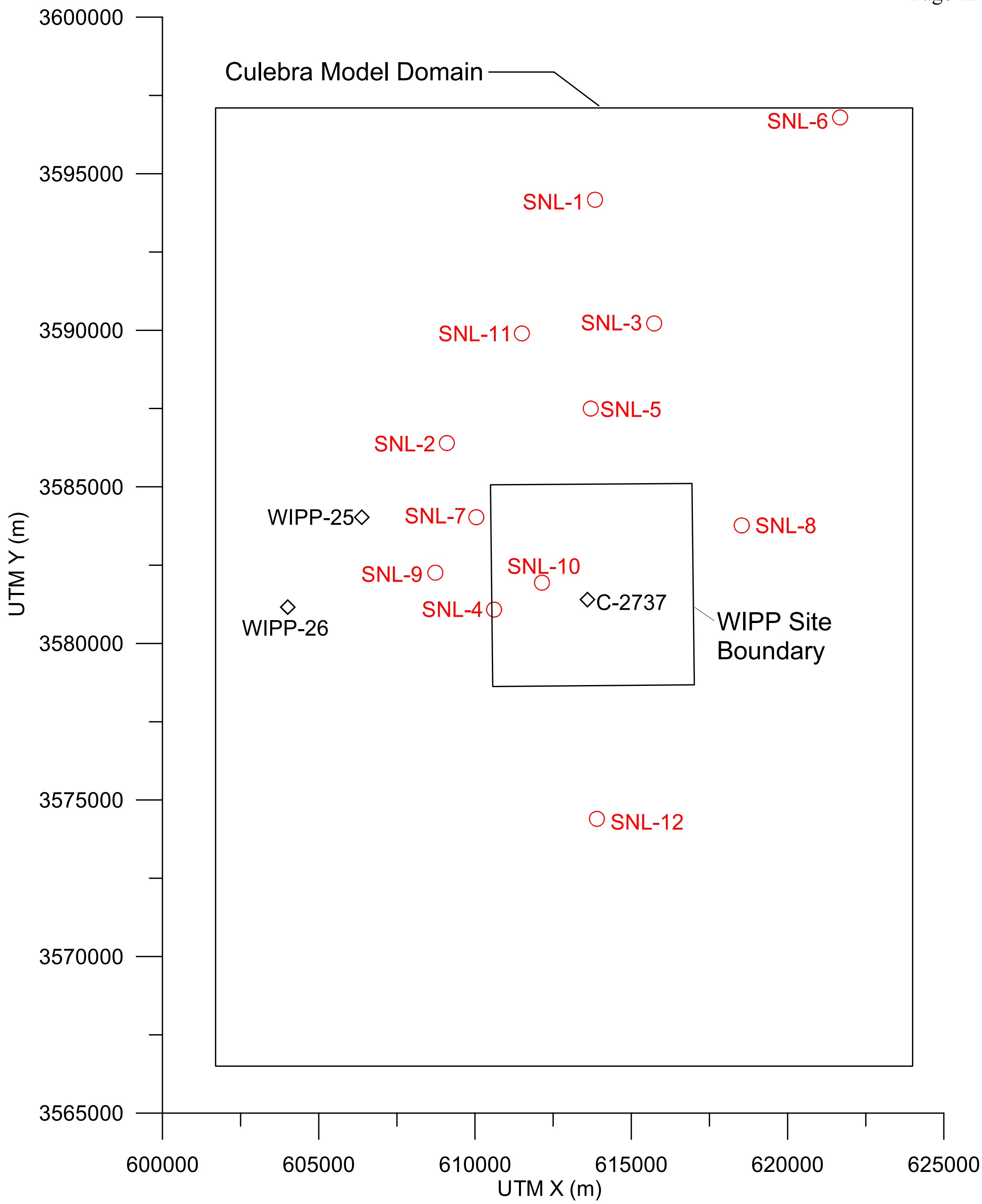

Figure 4-2. Locations of wells to be tested

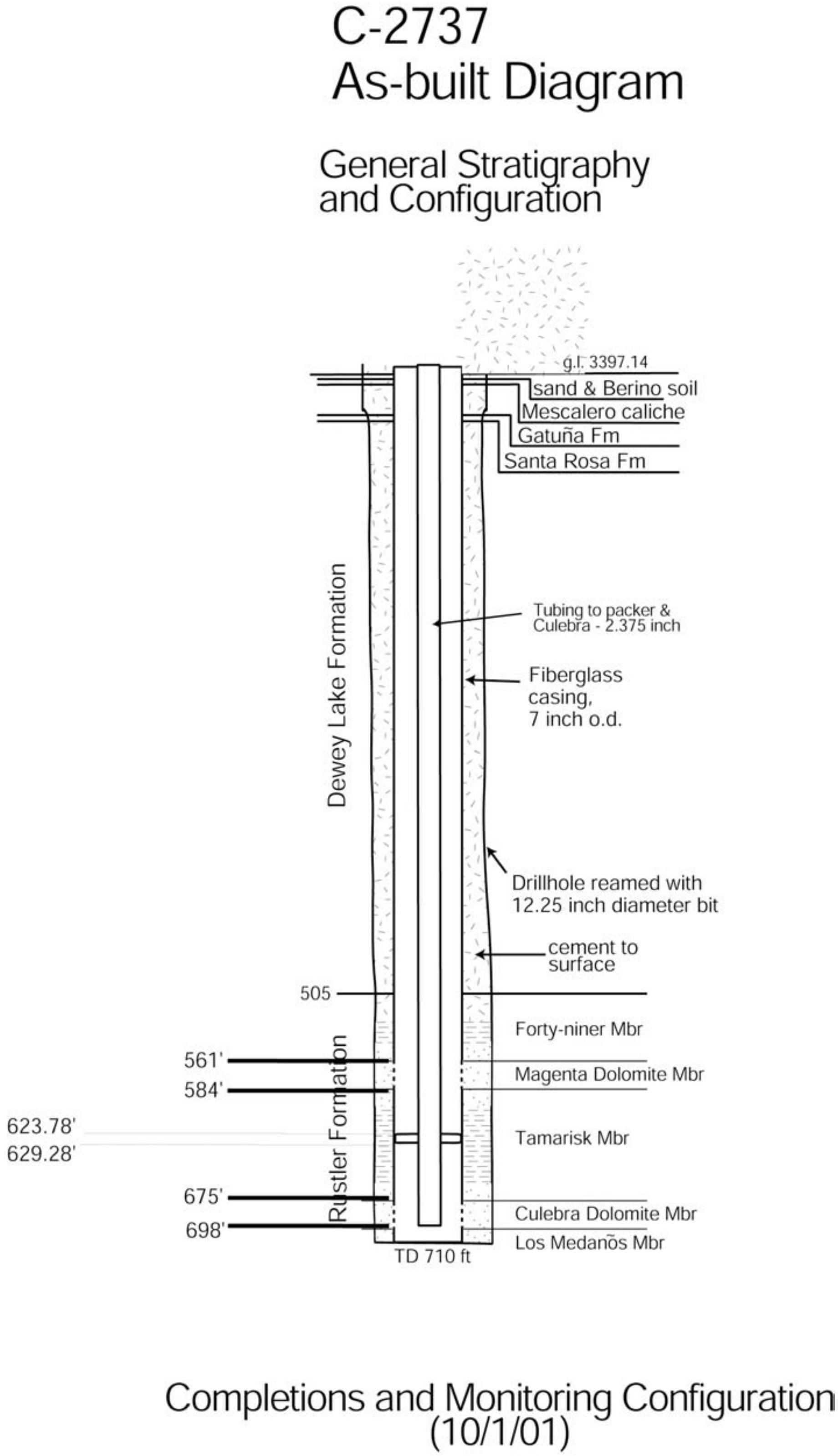

Figure 4-3. C-2737 well configuration.

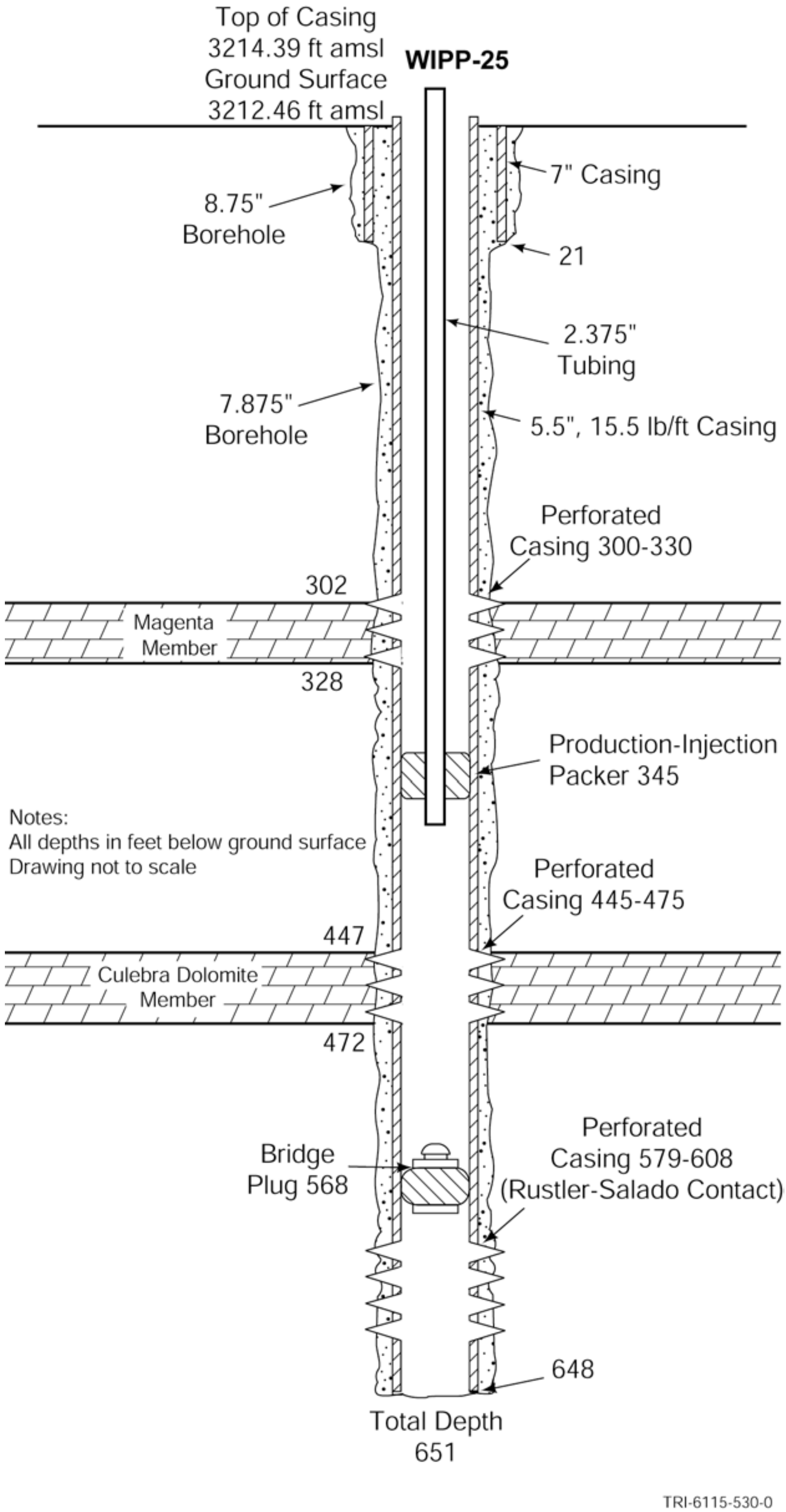

Figure 4-4. WIPP-25 well configuration.

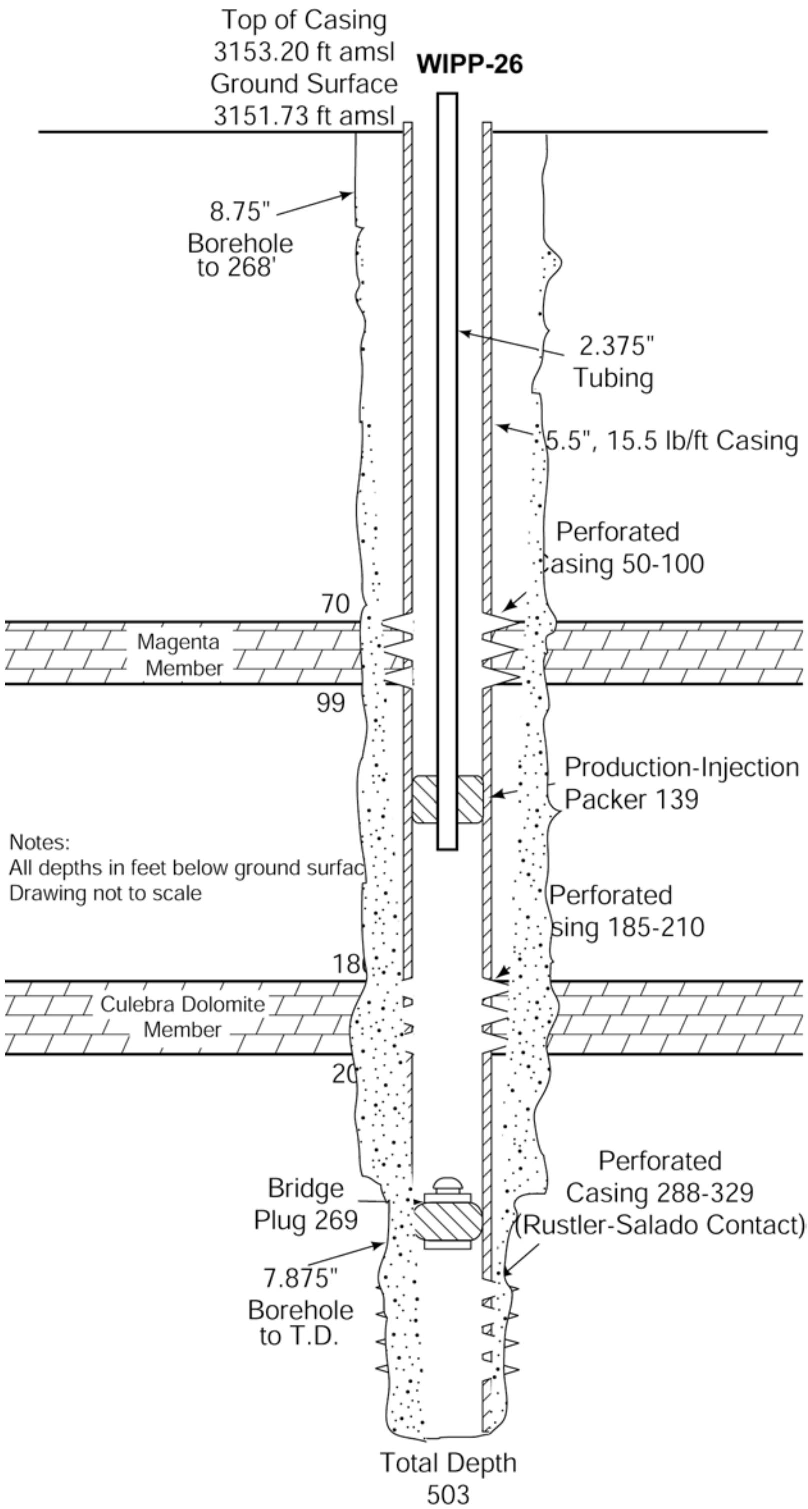

Figure 4-5. WIPP-26 well configuration

One or more wells will also be drilled in FY 2003 to allow evaluation and testing of a shallow perched zone at the base of the Santa Rosa. The first well will be south to southwest of the WIPP surface facilities, but no specific location has yet been established.

4.1 Testing Activities

In a new well, the following activities will occur:

1. The SNL Well Testing Lead (WTL) will evaluate the data from the well-development pumping performed by Washington Regulatory and Environmental Services (WRES) in order to design a hydraulic test(s) to meet the objectives for both the location and interval being tested. When the WTL has determined the type and duration of the hydraulic test(s) that will be run in an individual well, an appropriate test tool will be installed in the well. The type and configuration of test tools will vary from well to well based on the following:

- the type of test to be performed, e.g., slug or drill-stem test (DST), single-well pumping test, multipad pumping test;
- the objectives of the hydraulic testing (formation(s) or parameters of interest); and
- the well configuration (single-interval completion or dual-interval completion).

Due to the inherent variability in test-tool configurations that will be necessary to complete the hydraulic testing successfully, no standard configuration is provided in this TP. Each test-tool configuration will be documented in the scientific notebook and will be submitted as part of the final records package. The placement of the test tool within the borehole will be determined by the WTL. After the well has recovered from the well-development pumping, an appropriate hydraulic test(s) will be performed in accordance with the procedures given in Subsection 4.2.

2. Regardless of the type of hydraulic test(s) conducted, the WTL will evaluate all of the data collected on a real-time basis in order to ensure that the objectives of the test are being met prior to the termination of the test as well as to ensure that the tests are conducted with the maximum efficiency possible. The reader is referred to Subsections 4.2.1, 4.2.2, and 4.2.3 for additional information regarding the real-time data analysis associated with the various types of hydraulic tests.

3. All test equipment will be removed from the well, and the well will be configured for long-term monitoring.

This will complete SNL activities in the well. WRES will incorporate the wells into the long-term monitoring well network and begin monthly water-level measurements of the various water-bearing intervals as part of the GWMP.

4.2 Measuring and Test Equipment

Equipment needed for the hydraulic testing and data-collection activities will consist of equipment at the land surface and downhole equipment to be installed in the wells. Equipment will consist of either "off-the-shelf" items ordered directly from qualified suppliers or standard equipment provided by qualified service companies as required to complete their contracted tasks. No specially designed equipment is anticipated. All equipment used will follow the supplier's operation and calibration specifications and will be documented as part of the QA records and controlled following NP 12-1 (Subsection 4.6.4).

4.2.1 Surface Equipment

The surface equipment will include water-level sounders, water-quality measurement instruments, a mechanical flow meter, diesel-powered generators, and storage tanks. A data-acquisition system (DAS) to monitor pressure and flow rate and an electronic flow-control system will be used for any pumping test performed. A barometer will be used to measure atmospheric pressure at a given location before, during, and after any hydraulic test is performed as determined by the WTL. Equipment will be operated observing relevant SNL and WTS environmental safety and health (ES&H) procedures and protocols.

4.2.1.1 WATER-LEVEL SOUNDERS

Water levels in the wells will be measured before installing any equipment. Water levels may also be measured in other monitoring wells as designated in this TP or by the WTL. The water levels will be measured using Solinst electric water-level sounders according to SNL NWMP Technical Operating Procedure (TOP) 512 (Subsection 4.6.4). All measurements will be documented as part of the QA records. The Solinst meter consists of a graduated plastic tape with two wire leads, a water-level probe at the downhole end of the tape, batteries, and a signal light and buzzer mounted on a surface reel. When the water-level probe enters the water, the electrical conductivity of the water closes the electric circuit on the tape, activating the surface light and buzzer. The water level is read directly, in feet or meters, on the graduated plastic tape, at the observation-well measuring point, which will be clearly marked on the surface casing.

4.2.1.2 WATER-QUALITY MEASUREMENTS

Throughout the pumping phases of this program, the specific conductance, temperature, pH, and specific gravity of the produced water will be measured hourly, or as directed by the WTL, following SNL NWMP Activity/Project-Specific Procedure (SP) 13-3 (Subsection 4.6.4). The same measurements will also be performed on water bailed and/or swabbed from the wells prior to slug tests or DSTs. With the exception of specific gravity, these data will be considered qualitative in nature and will not be used for interpretation, but only to indicate relative changes in the quality of the fluid produced. The specific conductance and temperature will be measured with a Yellow

Springs Instruments S-C-T meter (or equivalent); pH with an Orion pH meter (or equivalent); and the specific gravity with a laboratory-grade hydrometer. Measurements will be documented as part of the QA records.

4.2.1.3 MECHANICAL FLOW METER

A totalizing mechanical flow meter will be used to measure the cumulative discharge during all pumping periods. The total discharge will be measured with a Carlon (or equivalent) in-line totalizing flow meter. The Carlon flow meter has a 1-in orifice, and is a brass-housed synthetic (noncorrosive) turbine flow meter designed for discharge rates of 1 to 20 gpm, with scale divisions of 0.1 gal. The Carlon flow meter is a totalizing flow meter and monitors only the total volume of fluid pumped. If necessary, the data from the totalizing flow meter can be used to calculate the average pumping rate by observing the meter at the beginning and end of a time period. The time-and-volume data can be used to calculate the average discharge rate for the time period in question. Totalizing-flow-meter data will be documented as part of the QA records. The flow meter will be checked during each pumping activity to verify that it is performing within design specifications by timing the filling of a container of known volume.

4.2.1.4 DIESEL-POWERED GENERATORS

Diesel-powered generators are needed to generate electricity for the pump and DAS. Diesel-powered generators will be operated in accordance with the instructions provided by the manufacturer. Operation of diesel generators is not a quality-affecting activity and, therefore, documentation of activities associated with the generators is not mandatory. No diesel fuel will be stored in separate containers at the well sites.

4.2.1.5 STORAGE TANKS

All groundwater produced from the wells during these activities will be stored in polyethylene tanks or steel frac-tanks at the well pad until such time that WRES disposes of the produced water by whatever means is appropriate.

4.2.1.6 DATA-ACQUISITION SYSTEM

All pumping tests conducted will be controlled and monitored using a computer-controlled DAS. The DAS will send and receive signals to and from the downhole pressure transmitters and record their responses on the computer's hard disk and on floppy diskettes. The DAS to be used will be PERM or Geomation.

The basic PERM system consists of a power-excitation input to access the downhole pressure transmitters and other gauges such as the flow meter, a digital voltmeter to observe the gauges' output signals, a data-control unit to access each gauge's signal, a programmable voltage standard to verify the signal output from gauge and excitation devices, and a computer to store and process the data. The PERM DAS will collect and process the gauges' input signals and store the data on hard disk and on floppy disks using SNL's PERM5, version 1.01, data-acquisition software, which has been qualified as software in accordance with NP 19-1 (Subsection 4.6.4). The PERM5 software requires a computer with a 100-MHz 486 processor (or higher) running DOS.

The Geomation System 2300 field monitoring and control system consists of modules that interface with various instruments by reading and recording amperage, resistance, and voltage (SDI-12 environmental instrument interface). In addition, the Geomation DAS can provide outputs to flow-control valves and other control devices. A computer will be used to provide a user interface and programming capabilities for the Geomation DAS via the Geonet Suite of software. The Geomation DAS will collect and process the gauges' input signals and store the data in memory until it can be archived to the computer's hard drive. The Geonet Suite of software qualifies as off-the-shelf software with no access to the source code. This type of off-the-shelf software does not fall under the QA requirements as per NP 19-1, however the DAS activity must comply with NP 9-1.

4.2.1.7 ELECTRONIC FLOW-CONTROL SYSTEM

Pumping rates during any pumping test will be controlled using an electronic flow-control system consisting of an in-line inductive flow meter, a programmable electronic flow controller, and a control valve or a variable-speed pump. The flow-control system will be operated with the DAS and flow rates will be recorded by the DAS. The components of the system are combined in a simple feedback loop. Thus, the flow-rate output from the flow meter will be used as input to the control valve or variable speed pump allowing stable flow-rate changes to be introduced from the DAS keyboard in less than 30 s. The set point can be set manually at the controller or remotely via the DAS. The design control range for flow rate is 0.2-5 gpm. Additional checks on the discharge rate may be provided using a calibrated bucket and stopwatch, and a mechanical flow meter.

4.2.1.8 BAROMETER

Barometric pressure will be monitored during all hydraulic tests using a 30-psia TROLL installed at the well site or a Druck PTX 260 series 0 to 17-psia pressure transmitter mounted at the well site. Druck PTX transmitters have a 9-30-V-DC input voltage with a 4-20-mA output signal, which is converted to a voltage output and monitored by the DAS. The barometric output monitored by the DAS and converted barometric pressure data will be recorded at the same frequency as the downhole pressure data. The operation of the 30-psia TROLL is similar to that described in Subsection 4.2.2.4 for standard TROLL pressure gages. Because the barometric pressure will be recorded by a stand-alone gage, the barometric output will not be recorded at the same rate as the DAS records other information. Some form of interpolation will be required to determine the barometric efficiency of the various wells as well as to make barometric pressure corrections to the pressure responses measured under open-hole conditions (if necessary).

4.2.2 Downhole Equipment

Downhole equipment will be operated from the surface and will consist of bailing and swabbing equipment to remove fluid from the borehole(s), inflatable packers, a sliding-sleeve shut-in tool, memory gauges, a submersible pump, and possibly pressure transmitters. The depths of all equipment installed in a well will be measured and documented relative to a known permanent datum, such as a survey marker established on the hydropad. A secondary datum, such as the top of the well casing, may be used as a reference point for depths provided that the elevation of the secondary datum relative to that of the primary datum is known and documented.

SNL will provide technical direction and assistance, as needed, to WRES or its contractors in installing all downhole equipment.

4.2.2.1 BAILING AND SWABBING EQUIPMENT

Bailing and swabbing equipment will be used to remove fluid from the tubing above the shut-in tool (Subsection 3.2.3) as needed to conduct slug and/or (DST (Subsection 4.2.1). The bailing and swabbing equipment will consist of artificial and/or natural rubber tubing wipers (swab cups) or downhole bailers supplied and operated by the pump-truck contractor. If bailing or swabbing is not possible or ineffective, the fluid level in the tubing string may be lowered by means of air lifting, whereby a hose or flexible tubing is used to inject compressed air below the water level in the tubing string at pressures and volumes sufficient to lift the fluid to land surface.

4.2.2.2 INFLATABLE PACKERS

Slug and drillstem testing (Subsection 4.2.1) will be conducted with a production-injection packer (PIP) set above the perforations or screen associated with the formation of interest on 2.375-in tubing. Compressed nitrogen or compressed air will be used to inflate the packers. The packers to be used will have uninflated diameters of 3.75-6.25 in, depending on the diameter of the casing in each well.

In addition, pumping tests (Subsection 4.2.2) conducted in wells that have dual completions such as C-2737 and WIPP-25 will require the use of PIPs to reconfigure the wellbore in such a way as to allow the pressure to be monitored in multiple formations simultaneously within the same borehole. Figures 2-3 and 2-4 show the current configurations of wells C-2737 and WIPP-25, respectively.

4.2.2.3 SLIDING-SLEEVE SHUT-IN TOOL

A Baski Access Port Valve (APV™) will be used to control access to the packer-isolated zones in the wells in which slug tests or DSTs are performed. An APV is a sliding-sleeve shut-in tool consisting of concentric sections of pipe with circular ports passing through the wall of the pipe.

In the open position, the ports on the two sections line up, allowing fluid to pass from the tool string to the well. When one of the sections slides vertically relative to the other, the ports no longer line up (closed position), and the fluid cannot pass from the tool to the well. The Baski APVs are controlled from the surface. Gas or hydraulic pressure is applied to a piston through a control line run alongside the tool string to open or close the sleeve. Separate pistons and control lines are used to open and close the sleeve. No tubing movement or weight change to the tubing above the shut-in tool is required to operate this shut-in tool, thus minimizing tool-induced pressure disturbances in the test zone. APVs will be installed between two 2.375-in pup joints beneath PIPs.

4.2.2.4 TROLL MEMORY GAUGES

TROLL 4000 and miniTROLL downhole memory gauges will be used as the primary data-acquisition instrument during slug tests or DSTs (Subsection 4.2.1). Any time that a well is pumped and another well, not on the active hydropad, is monitored, TROLLs will also be used to monitor the pressure response in the nearby well(s). TROLLs are manufactured by In-Situ, Inc., and consist of a downhole pressure transducer and programmable data logger. They are installed at a known depth below the water surface in a well. The data logger is accessed from land surface by RS-422 or RS-232 cables, allowing the data-acquisition rate to be programmed and accumulated data to be downloaded to any laptop computer using a Windows 95, 98, 2000, or NT operating system and the most current version of the Win-Situ software. These battery-operated devices can operate for over a year without battery replacement. The use of the TROLL memory gauges will allow efficient use of manpower and provide useful data at any desired data density over extended time periods.

4.2.2.5 SUBMERSIBLE PUMP

In most cases, an electric submersible pump with a production capacity of up to 5 gpm will be used for groundwater sampling and possibly pumping tests (Subsection 4.2.2) under open-hole conditions. It is anticipated that a larger-capacity pump, on the order of 80 gpm, may be required for one or more multipad tests (Subsection 4.2.3). For pumping tests, the pump will be installed with an in-line check valve so that the pump tubing column can be filled with water at the start of pumping to ensure immediate flow control and regulation, and to ensure that water will not drain back through the pump when the pump is turned off. All wiring of submersible pumps will be performed by a licensed pump installer.

4.2.2.6 PRESSURE TRANSMITTERS

Druck PTX 161 pressure transmitters (or equivalent) will be used to monitor the changes in pressure in all wells monitored on the active hydropad during any pumping tests (Subsections 4.2.2 and 4.2.3). Two transmitters will be used at all times in each well, or for each formation as necessary, to ensure continued data collection in the event that one transmitter fails. The transmitters will be strapped to the discharge tubing above the pump. The Druck PTX 161 pressure transmitters (or equivalent) have a 0 to 300-psig range of operation. These pressure transmitters will be monitored with the PERM or Geomation DAS (Subsection 3.1.6), which will record both the 4- to 20-mA output from the gages and the converted data in the desired pressure units.

4.3 Test Requirements and Procedures

The activities discussed in this TP have been designed so that the data collected are of the highest possible value, and are more than adequate to meet specific program objectives.

4.3.1 Test Requirements

The testing elements of the data-collection activities require specific initial and operational conditions for maximum success. Pressures in the formation of interest at the well to be tested, other wells being monitored that are completed to the formation of interest, and other formations being monitored for pressure response associated with the test must be stabilized (changing <0.5 psi/day) before any hydraulic test is initialized. The fluid density in the well being tested must be uniform before testing begins. The pumping rate during a pumping test should ideally be constant within approximately 5%, but in any event must be well documented.

The test equipment used for the data-collection activities has to:

- provide quality data to support test objectives;
- perform according to design specifications; and
- be calibrated, as appropriate, according to standards acceptable under SNL NP 12-1 (Subsection 4.6.4).

4.3.2 Test Procedures

Five different types of hydraulic tests may be performed depending on the conditions actually encountered. The following subsections list the different hydraulic tests that may be performed, provide general criteria for their selection, and define the procedures that will govern their performance.

4.3.2.1 SLUG AND DSTs

Slug tests or DSTs will be performed in any wells incapable of sustaining a pumping rate of at least 1 gpm, which will likely include most Magenta wells and a few Culebra wells. Slug tests or DSTs may also be performed in some of the new Culebra, Dewey-Lake, and Santa-Rosa wells initially in order to get a preliminary idea of the hydraulic characteristics of the formation at that location. Future testing in these wells will be designed based upon the preliminary hydraulic data.

A DST is simply a slug test that is shut-in before complete water-level recovery has occurred. The slug portion of a DST is referred to as a flow period and the shut-in portion is referred to as a buildup period. The advantages of a DST relative to a slug test are that it takes less time to complete and provides two data sets that can be analyzed instead of one. The disadvantage of a DST relative to a slug test is that the flow-period data set is less definitive than a full slug data set.

All slug tests and DSTs will be conducted in accordance with the following TP procedures. A PIP (Subsection 4.2.2.2) will be set on 2.375-in tubing in the well casing above the perforations or screen with a sliding-sleeve shut-in valve (Subsection 4.2.2.3) immediately below the PIP. The PIP size will be selected so that the casing inside diameter (I.D.) is not more than twice the uninflated diameter of the PIP. The exact placement of the PIP is not critical, as long as it is within 20 ft of the uppermost perforation (slot) and its position is carefully measured. The shut-in valve will be in the open position when the test equipment is installed in the well. Once at the desired depth, the PIP will be inflated (set). After allowing the formation that is to be tested to re-equilibrate, the shut-in valve will be closed.

A TROLL (Subsection 4.2.2.4) will be strapped to the tubing at a depth below the stabilized formation water surface calculated to provide a pressure of 90–95% of the maximum pressure for that instrument. The pressure sensor of the TROLL will be connected to the formation of interest using a feed-through line passing through the PIP or other configuration as deemed appropriate. Barometric pressure will be recorded during all slug tests using a 30-psia TROLL. The depths of all equipment in the well will be carefully measured and documented in the scientific notebook.

With the shut-in valve closed, the tubing will be bailed and/or swabbed to remove some of the water above the formation of interest and the specific gravity of this water will be measured. The removal of water from the tubing (effectively under-pressuring the formation) is referred to as a slug-withdrawal test. The amount of water to be removed will be determined on-site by the WTL, based on the following guideline: the water level will be lowered to provide a pressure no less than 5% of the maximum pressure for the TROLL when the shut-in valve is opened. After bailing and/or swabbing, the water level in the tubing will be measured using a Solinst meter (Subsection 4.2.1.1) in accordance with TOP 512 (Subsection 4.6.4). It should be noted that this type of test can also be accomplished by adding water to the tubing (effectively over-pressuring the formation) rather than removing water from the tubing. This is referred to as a slug-injection test and may be performed as part of this TP if the circumstances are deemed appropriate by the WTL.

The pressure in the formation of interest below the PIP will be allowed to stabilize until the rate of change is <0.5 psi/day. At the direction of the WTL, the shut-in tool will be opened to initiate a slug test. The WTL will evaluate the test data in real time to determine if the test should be continued as a slug test or converted to a DST. Subject to the discretion of the WTL, the following guidelines will be used to determine if and when a slug test will be converted to a DST:

- If 50% of the initial slug has dissipated after 3 h, the test will remain a slug test.

- If 50% of the initial slug dissipates between 3 and 24 h, the shut-in valve will be closed and the test will be converted to a DST when 80% of the slug has dissipated.

- If 50% of the initial slug has not dissipated after 24 h, the shut-in valve will be closed and the test will be converted to a DST whenever 50% dissipation occurs.

Slug tests and DST buildup periods will continue until at least 98% pressure recovery has occurred. For a slug test, the shut-in valve will then be closed and the tubing bailed and/or swabbed to create a pressure differential approximately half of that created for the first slug test. For a slug test converted to a DST at 80% slug dissipation, the tubing will also be bailed and/or swabbed to create a pressure differential approximately half of that created for the first test. No bailing and/or swabbing will be required for a test converted to a DST at 50% slug dissipation. After the pressure disturbance caused by bailing and/or swabbing has dissipated, the shut-in valve will be opened to begin a second slug test or DST. The second test will be an exact duplicate of the first test, but with half of the initial pressure differential. Testing may be terminated at any time after 98% pressure recovery has occurred.

Data-acquisition rates will be set as fast as possible at the start of each test event (slug/flow or buildup) and will then be systematically decreased throughout the test to provide a reasonably uniform distribution of data with respect to the logarithm of elapsed time. If the WTL deems it appropriate to employ the use of a DAS (Subsection 4.2.1.6) to monitor slug-testing activities, all pertinent information will be documented in the scientific notebook.

During slug and DST testing activities, pressure-response data will be evaluated on a real-time basis by the WTL in order to determine that the objectives of the test are being met and that the test proceeds in the most efficient and effective manner. Standard straight-line and diagnostic derivative techniques described in Horne (1995) and Peres (1989) will be employed to assess both the progress of the test and to determine the flow regime of the system being tested.

4.3.2.2 SINGLE-WELL PUMPING TESTS

Constant-rate pumping tests will be performed in any wells capable of sustaining a pumping rate of approximately 1 gpm or more. All single-well pumping tests will be conducted in accordance with the following TP procedures. A submersible pump (Subsection 4.2.2.5) will be set in the well approximately 5 ft below the perforations or screen for the formation of interest on 2.375-in tubing. A check valve will be installed above the pump to prevent water in the tubing column from draining back down through the pump when the pump is turned off. Two pressure transmitters (Subsection 4.2.2.6) will be strapped to the tubing approximately 10 ft above the pump. The depths of all equipment in the well will be measured to the nearest 0.01 ft and documented in the scientific notebook.

In some cases, when one of the objectives of the hydraulic testing is to assess the hydraulic connection of the formation being tested with water-bearing formations above and/or below, PIPs (Subsection 4.2.2.2) will have to be installed in order to isolate the various water-bearing formations and additional pressure transmitters will have to be installed in the pumping well in order to monitor the various other water-bearing formations of interest associated with the particular test being conducted. Again, these decisions and associated configurations will be made on a case-by-case basis based upon prior information of the hydraulic system at that location. It is anticipated that the WIPP-25 hydraulic test will be of this nature. The rationale for all testing decisions and all testing configurations will be documented in the scientific notebook associated with the respective wells.

Prior to the initiation of the pumping test, the pump will be turned on briefly in order to perform several checks of the system. These include:

- ensuring that the submersible pump is operating properly;
- filling the 2.375-in tubing string with fluid to ensure that:
  - the check valve above the pump is holding,
  - there is fluid filling the surface discharge lines to ensure that both the mechanical and the electronic flow meters will register flow rates immediately upon initiation of the formal pumping test; and
- ensuring that all of the electronic equipment both at the surface and downhole is operating properly.

When all of these checks and any others that the WTL deems necessary have been made, the pumping will be terminated and the system will be allowed to equilibrate fully prior to the initiation of the formal pumping test.

After it has been established that the formation of interest has re-equilibrated from the pre-test pumping, the pump will be turned on and operated at a constant rate (determined during water-quality sampling and/or well-development activities) to produce water from the formation of interest. Although the primary purpose of these tests is to obtain estimates of n or T for the pumping well, any nearby wells that may respond to the test will be monitored as well. The wells to be monitored during any pumping test will be determined by the WTL on a case-by-case basis based upon prior knowledge of the hydraulic system at that location. Monitoring of these wells will be performed using TROLLs (Subsection 4.2.2.4). In some cases, a qualitative assessment of any hydraulic connection between the formation being tested and water-bearing formations above and/or below the formation being tested will be made. Should a hydraulic connection between water-bearing formations be identified, the design and duration of the test may be modified in real-time in order to maximize the information obtained or additional testing may be scheduled at that location with modified test objectives. Pumping time may vary from 2–10 days depending on the local T of the formation of interest and/or the observed pressure response(s). Real-time analysis of the pressure data from the pumping and monitoring (if any) wells will be used by the WTL to establish the time when the pump may be turned off and the time at which recovery monitoring will be terminated. Recovery monitoring will typically continue for a period at least twice as long as the pumping duration.

The DAS (Subsection 4.2.1.6) will be used for any pumping test to record downhole pressure and flow rate in the pumping well and any other wells located on the same hydropad. Data-acquisition rates will be set as fast as possible at the start of pumping and recovery and will then be systematically decreased to hourly, providing at least 20 readings for each log cycle of elapsed time. Barometric pressure may be collected through the use of a 30-psia TROLL instead of through the use of a DAS using the equipment described in Subsection 4.2.1.8. Manual totalizing-flow-meter (Subsection 4.2.1.3) readings and water-quality (temperature, specific conductance, pH, and specific gravity) measurements (Subsection 4.2.1.2) will be made no less frequently than hourly during pumping. During the recovery period, the water level in the tubing will be measured several times per day to verify that the check valve is not leaking.

During single-well testing activities, pressure-response data will be evaluated on a real-time basis by the WTL in order to determine that the objectives of the test are being met and that the test proceeds in the most efficient and effective manner. Standard straight-line and diagnostic derivative techniques as described in Horne (1995) will be employed to assess both the progress of the test and to determine the flow regime of the system being tested.

In some cases, when one of the objectives of the hydraulic testing is to assess the hydraulic connection of the formation being tested with water bearing formations above and/or below, PIPs (Subsection 4.2.2.2) will be installed in order to isolate the various water bearing formations and additional pressure transmitters will have to be installed in the pumping well in order to monitor the various other water-bearing formations of interest associated with the particular test being conducted. Again, these decisions and associated configurations will be made on a case-by-case basis based upon prior information of the hydraulic system at that location. The rationale for all testing decisions and all testing configurations will be documented in the scientific notebook associated with the respective wells.

4.3.2.3 MULTIPAD-PUMPING TESTS

Constant-rate, multipad-pumping tests are performed to obtain transient head response data from observation wells spread over an area of several square miles. They differ from the single-well pumping tests described in Subsection 4.3.2.2 primarily in terms of duration. Multipad pumping tests typically last from one to several months to allow distant observation wells time to respond.

All multipad pumping tests will be conducted in accordance with the following TP procedures. A submersible pump (Subsection 4.2.2.5) will be set in the well approximately 5 ft below the perforations or screen for the formation of interest on 2.375-in tubing. A check valve will be installed above the pump to prevent water in the tubing column from draining back down through the pump when the pump is turned off. Two pressure transmitters (Subsection 4.2.2.6) will be strapped to the tubing approximately 10 ft above the perforations. The depths of all equipment in the well will be carefully measured and documented in the scientific notebook.

Prior to the initiation of the pumping test, the pump will be turned on briefly in order to perform several checks of the system. These include:

- ensuring that the submersible pump is operating properly;
- filling the 2.375-in tubing string with fluid to ensure that:
    - the check valve above the pump is holding,
    - there is fluid filling the surface discharge lines to ensure that both the mechanical and the electronic flow meters will register flow rates immediately upon initiation of the formal pumping test; and
- ensuring that all of the electronic equipment both at the surface and downhole is operating properly.

When all of these checks and any others that the WTL deems necessary have been made, the pumping will be terminated and the system will be allowed to fully equilibrate prior to the initiation of the formal pumping test.

After it has been established that the formation of interest has re-equilibrated-in the pumping well and observation wells-from the pretest pumping, the pump will be turned on and operated at a constant rate (determined during water-quality sampling and/or well-development activities) to produce water from the formation of interest. TROLLs (Subsection 4.2.2.4) will be set in any monitoring wells that may show a pressure response during the pumping test. Monitoring wells for each multipad test will be determined by the WTL on a case-by-case basis. Real-time analysis of the pressure data from the pumping and monitoring wells will be used by the WTL to establish the time when the pump may be turned off and the time at which recovery monitoring will be terminated. The objectives of any of the multipad pumping tests will be to determine the flow geometry and the local S and T of the formation being tested. In addition, the multipad pumping tests will provide transient pressure response data at locations in the vicinity of the WIPP Site against which the Culebra flow model can be calibrated. Also, in some cases, a qualitative assessment of any hydraulic connection between the formation being tested and water-bearing formations above and/or below the formation being tested will be made. Should a hydraulic connection between water-bearing formations be identified, the design and/or duration of the test may be modified in real time in order to maximize the information obtained, or additional testing may be scheduled at that location with modified test objectives. Pumping time may vary from 1-3 months depending on the observed pressure response(s).

The DAS (Subsection 4.2.1.6) will be used for any pumping test to record downhole pressure and flow rate in the pumping well and any other wells located on the same hydropad. Data-acquisition rates will be set as fast as possible at the start of pumping and recovery and will then be systematically decreased to hourly, providing at least 20 readings for each log cycle of elapsed time. Barometric pressure may be collected through the use of a 30-psia TROLL or through the DAS using the equipment described in Subsection 4.2.1.8. Manual totalizing-flow-meter (Subsection 4.2.1.3) readings and water-quality (temperature, specific conductance, pH, and specific gravity) measurements (Subsection 4.2.1.2) will be made no less frequently than hourly during pumping. During the recovery period, the water level in the tubing will be measured several times a day to verify that the check valve is not leaking.

During multipad testing activities, pressure-response data will be evaluated on a real-time basis by the WTL in order to determine that the objectives of the test are being met and that the test proceeds in the most efficient and effective manner. Standard straight-line and diagnostic derivative techniques described in Horne (1995) will be employed to assess both the progress of the test and to determine the flow regime of the system being tested.

4.3.2.4 SCANNING COLLOIDAL BOROSCOPE

Direct measurement of the direction of groundwater flow is needed in a number of wells to verify that models are accurately simulating flow. Therefore, the screened intervals of both Culebra and Magenta wells will be logged in wells selected by the SNL PI using the scanning colloidal borescope. The scanning colloidal borescope images colloidal-size particles moving with the water through the wellbore, and tracks their motion to determine the direction and velocity of groundwater flow at that location. It differs from the colloidal borescope described in Beauheim (2000) in that it has a variable focal length that allows scanning over a 0.5-m thickness for each placement of the tool, instead of a fixed focal length. Thus, the scanning colloidal borescope allows all flowing zones to be identified and characterized. All scanning colloidal borescope activities will be conducted under the direction of the SNL PI. This service will follow QA grading procedure SP 1-1 and procurement procedure NP 4-1 (Subsection 4.6.4). Upon completion, the contractor conducting the scanning colloidal borescope activities will provide all results in both paper and digital format as well as all applicable supporting documentation and records for equipment used. This equipment will be supplied in a calibrated condition by the contractor.

4.3.2.5 MODIFICATIONS TO TEST PROCEDURES

Modifications to test procedures may be required during testing activities. These modifications will be conducted at the direction of the WTL and will be documented in the scientific notebook as part of the QA records as well as any supporting records and reports. Such modifications are anticipated as normal operational procedures and will not be reported as nonconformances that require corrective action.

4.4 Data-Acquisition Plan

Both manually and electronically collected data will be acquired during the hydraulic testing activities. The following types of data will be recorded:

- electronically collected downhole pressure data;
- electronically and/or manually collected pumping rate and volume data from wells being pumped;
- electronically collected barometric-pressure data;
- manually collected water-level data;
- manually collected water-quality data concerning the temperature, pH, specific gravity, and specific conductance of fluid produced during pumping, bailing and/or swabbing; and
- manually collected data on equipment and instrument configurations in the wells and at the surface.

4.4.1 Scientific Notebooks

Scientific notebooks will be used in accordance with NP 20-2 to document all activities and decisions made during the hydraulic-testing activities. Specific information to be recorded in the scientific notebooks includes:

- a statement of the objectives and description of work to be performed at each well, as well as a reference to this TP;
- a written account of all activities associated with each well;
- documentation of safety briefings;
- a list of all equipment used at each well, including make, model, and operating system (if applicable);
- a description of standards used for on-site instrument calibration and calibration results;
- traceable references to calibration information for instruments and/or gauges calibrated elsewhere;
- a sketch, showing all dimensions, of each downhole equipment configuration;
- tubing tallies and other equipment measurements;

- manually collected water-level measurements;
- manually collected water-quality data concerning the specific conductance, specific gravity, pH, and temperature of fluid produced during pumping, bailing and/or swabbing;
- entries providing the names, starting times, and completion times of all data files created with the DAS software or WinSitu, as well as tables showing the configuration information (pressure transmitter serial number, calibration coefficients, etc.) entered into PERM5 to initiate each data file; and
- discussion of the information and/or observations leading to decisions to initiate, terminate, or modify activities.

All entries in the scientific notebooks will be signed or initialed and dated by the person making the entry. The scientific notebook(s) for each well will be reviewed by an independent, technically qualified individual within 2 weeks of the end of each major field activity (pumping associated with water quality sampling, hydraulic testing, and logging with scanning colloidal borescope) at that well to verify that sufficient detail has been recorded to retrace the activities and confirm the results.

Manually collected water-quality data and water-level measurements may also be recorded on specially prepared forms rather than in the scientific notebooks when that would provide a more efficient means of data collection and tracking. Use of such forms will be noted in the scientific notebooks and these forms will be submitted as QA records.

4.4.2 Electronic Data Acquisition

TROLL memory gauges (Subsection 4.2.2.4) will be used for monitoring and testing activities. The PERM or Geomation DAS described in Subsection 4.2.1.6 will be used at locations where pumping tests are performed. If used, the DAS will record downhole pressures in all wells located on the hydropad being tested, and pumping rates. Electronic data file-management systems will be documented in the scientific notebooks for these activities. These electronic data files will be submitted as QA records according to NP 17-1 (Subsection 4.6.4).

4.4.3 Manual Data Acquisition

Manual data collection will be carried out using either scientific notebooks or forms designed specifically for each activity or data type. To minimize transcription errors and multiple documentation of the same information, the use of forms specified in the WIPP procedures is not mandatory. The WTL will determine the means of documenting manually acquired data and will ensure that all quality-affecting information is documented.

4.4.4 On-Site Data Validation

During the field activities, the WTL will evaluate the data as they are acquired. The data will be diagnosed for any tool failure and/or procedure-induced effect that may affect the data quality. The WTL will take immediate action (if required) to make any necessary changes to the equipment configuration or the procedures to assure the data quality is consistent with the objectives of these activities. Data associated with these testing activities provided by entities other than SNL will be checked for accuracy and adequacy by the WTL and documented in the scientific notebook as such. Any deficiencies will be noted. This on-site real-time data evaluation will follow NP 9-1 (Subsection 4.6.4) as a method of determining if the data are acceptable and will be documented in the scientific notebook.

The WTL will use real-time evaluation of the acquired data during any given activity to assure that the data are usable in a detailed interpretation, the conditions can be maintained over the planned duration of the activity, and that an activity will not be terminated before the minimum objectives can be achieved under the given time constraints. The WTL may utilize some or all of the following procedures and analytical tools:

- To assure that the acquired data satisfy program plans, the WTL may use the same interpretation techniques during the data-validation process as will be used in later interpretation of these data.

- The WTL may use specialized plots to interpret the formation response and to identify the time domain of that response, such as the wellbore storage, transition, stabilization, or other response phase.

- The WTL may use real-time analysis of the acquired data to determine the time when continuing the activity will provide no further improvement in the interpreted results within the program's time and budget constraints.

- The WTL may use real-time analysis to determine whether an activity can be terminated earlier than planned, and to develop a revised schedule as appropriate.

If at any time the WTL determines that an activity objective cannot be accomplished due to time constraints, problems concerning the performance of the equipment, or unsuitability of initial conditions, the WTL may terminate the activity. The WTL will document all real-time evaluation of data in the scientific notebook.

4.5 Sampling and Sample Control

All new wells and wells to be tested will be pumped to allow water samples representative of the completion formation to be collected. As discussed in Section 4, the wells will be pumped until water-quality parameters (electrical conductivity and specific gravity) are stable within approximately 5% while two wellbore volumes are pumped. When that occurs, water samples will be collected for laboratory analysis of major ions (Na, Mg, SO_4, Cl, K, Ca, sulfate, and alkalinity).

Water-quality sampling will be performed in all wells to provide baseline information and allow inferences to be made regarding the origins and flow paths of the groundwater. Water samples will be collected at the end of well-development activities for those wells at which pumping tests do not appear to be feasible, or for replacement wells where hydraulic testing is not necessary. During the pumping tests at the remainder of the wells, water-quality parameters, as mentioned above, will be collected no less frequently than every hour to assess their stability. Prior to turning off the pump, samples will be collected for laboratory analysis of major-ion concentrations, also listed above. Age dating may also be performed on Dewey-Lake water samples. Samples will be collected and controlled in accordance with SNL NP 13-1 (Subsection 4.6.4). The chain of custody for the samples when they are transferred to the SNL analytical laboratory will be established in accordance with SP 13-1.

Water samples will be collected in 1-L acid-washed polyethylene bottles. Each bottle will be rinsed three times with water from the pump discharge line before a sample is collected. Two bottles will be filled in immediate succession. The first bottle will be filled completely. The second bottle will be filled approximately halfway. Approximately 2 mL of HNO_3 (nitric acid) Ultrex II (70.6 wt %) or equivalent) will be added to this bottle, and then the bottle will be filled to the shoulder. (Note: chemical goggles and protective gloves must be worn while handling HNO_3.) The lid will be screwed on and the bottle agitated. The pH of the sample will then be checked and, if it is above 2.0 standard units, 1 mL of HNO_3 will be added, the sample agitated, and the pH checked again. This procedure will continue until the pH is less than 2.0.

After filling, the lids of all sample bottles will be secured with electrical tape. A label will be affixed to each bottle bearing the information listed below, and the label will be completely covered with clear packing tape. The label will contain the following information, written using an indelible marker:

- project name (WIPP),
- sample number,
- sample location (e.g., Magenta),
- well designation,
- collector's name,
- date and time,
- type of sample (groundwater),
- acid wash (yes or no),
- parameter or destination,

- type of preservative (HNO_3 or none),
- bottle number, and
- method of collection (filtered or unfiltered).

After collection, water samples will be stored in a cooler until they can be delivered to the SNL analytical laboratory, which should occur as soon as practicable.

4.6 Quality Assurance

4.6.1 Hierarchy of Documents

Several types of documents will be used to control work performed under this TP. If inconsistencies or conflicts exist among the requirements specified in these documents, the following hierarchy (in decreasing order of authority) shall apply:

- memoranda or other written instructions used to modify or clarify the requirements of the TP (most recent instructions having precedence over previous instructions),
- this TP,
- NPs (Subsection 4.6.4), and
- SPs and TOPs.

SNL QA concurrence will be obtained and/or corrective action reports will be written for modifications to QA procedures implemented for work conducted under this TP.

4.6.2 Quality-Affecting Activities

Activities performed under this TP are quality-affecting with the following exceptions:

- water-quality measurements, except specific gravity (see Subsection 3.1.2);
- operation of diesel-powered generators (see Subsection 3.1.4);
- assistance provided by the manufacturer/contractor in the installation of tools and equipment;

- support services for tasks that do not involve data collection, such as pump trucks, machining, welding, fishing services, fuel, etc.; and

- water storage and disposal.

Activities that are not quality-affecting are not subject to the requirements of the SNL QA program.

4.6.3 Quality Assurance Program Description

SNL activities are conducted in accordance with the requirements specified in the Quality Assurance Program Document (QAPD) (U.S. DOE, 2002a), or subsequent revisions of this document. The requirements and guidance specified in the QAPD are based on criteria contained in American Society of Mechanical Engineers (ASME) (1989a), ASME (1989b), ASME (1989c), or U.S. EPA (1993). The requirements of U.S. DOE (2002a) are passed down and implemented through the SNL NWMP QA procedures.

4.6.4 NPs, SPs and TOPs

The following NPs, SPs, and TOPs are applicable to the work described in this TP. Note that the versions listed below may not be the current versions. Always check the SNL NWMP web site (www.nwmp.sandia.gov/onlinedocuments/) to find the current version of these or other NPs, SPs, or TOPs.

- NP 2-1, “Qualification and Training;”

- NP 4-1, “Procurement;”

- NP 9-1, “Analyses;”

- NP 12-1, “Control of Measuring and Test Equipment;”

- NP 13-1, “Sample Control;”

- NP 17-1, “Records;”

- NP 19-1, “Software Requirements;”

- NP 20-1, “Test Plans;”

- NP 20-2, “Scientific Notebooks;”

- SP 1-1, “QA Grading;”
- SP 5-1, “Engineering Drawings;”
- SP 13-1, “Chain of Custody;”
- SP 13-3, “Field Water-Quality Measurements;” and
- TOP 512, “Depth-to-Water Measurement Using Solinst Brand Electric Sounder.”

Existing procedures implemented in the field cannot be expected to anticipate every possible event affecting the tests. Therefore, the WTL is tasked with implementing appropriate measures during the conduct of the tests. These technical decisions will be documented in the scientific notebook.

4.6.5 Data Integrity

Care will be taken throughout the performance of the operations for this TP to ensure the integrity of all data collected including documentation on hard copy and data collected on magnetic media. Duplicate copies of all data will be produced no less frequently than monthly and the duplicate copies will be maintained at a location separate from the well site to ensure that data are not lost. Data collected shall not be released unless and until the data are reviewed and approved by the WTL.

4.6.6 Records

Records shall be maintained as described in this TP and applicable QA implementing procedures. These records may consist of bound scientific notebooks, loose-leaf pages, forms, printouts, or information stored on electronic media. The WTL will ensure that the required records are maintained and are submitted to the SNL NWMP Records Center according to NP 17-1 (Subsection 4.6.4).

4.6.6.1 REQUIRED QA RECORDS

As a minimum, QA records will include:

- scientific notebooks;
- NPs, SPs, and TOPs used;
- calibration records for all controlled equipment;
- equipment-specification sheets or information;

- photographs taken of the equipment and activities, with a log listing the photographs and describing what is seen;
- data files collected by TROLLs and/or the DAS, with a log listing the files and defining their contents;
- all forms containing manually collected data;
- a log of all samples collected;
- copies of all permits obtained; and
- reports (e.g., gamma and perforation logs) provided by contractors.

4.6.6.2 MISCELLANEOUS NON-QA RECORDS

Additional records that are useful in documenting the history of the activities but are considered non-QA records may be maintained and submitted to the SNL NWMP Records Center. These records include:

- safety briefings,
- as-built diagrams of equipment supplied by contractors,
- pump-truck and other equipment certifications,
- equipment manuals and specifications,
- information related to operation of diesel generators,
- equipment manifests, and
- cost and billing information regarding contracted services.

These records do not support performance assessment or regulatory compliance and, therefore, are not quality-affecting information.

4.6.6.3 SUBMITTAL OF RECORDS

Records resulting from work conducted under this TP, including forms and data stored on electronic media, will not be submitted to the SNL QA staff for review and approval individually. Instead, the records will be assembled into a records package or packages, which will be reviewed by the WTL before being submitted for QA review.

5 TRAINING

All SNL and WIPP-Site contractor personnel are required to take and pass WIPP General Employee Training (GET) followed by annual refreshers to work at the WIPP Site. All personnel who will perform quality-affecting activities under this TP must have training in the SNL QA program (Form NP 2-1-1), must view the current QA refresher video, and must read SNL NP 12-1, NP 13-1, NP 20-2, and SP 13-1 (Subsection 4.6.4). They must also read the procedures outlined in this TP, the Primary Hazard Screening (PHS), and all applicable NPs, SPs and TOPs listed in Subsection 4.6.4, but no additional training in those procedures is required. No other special training requirements are anticipated in addition to the GET and the safety briefings described in Section 6.

6 HEALTH AND SAFETY

SNL field operations will be conducted on land controlled by WRES and the field operations team assembled for this TP will follow all WRES safety practices and policies. Operational safety for individual field operations will be addressed through an ES&H PHS (SNL2A00137-001) and a Hazard Analysis (HA) developed by SNL. Project-specific WIPP-Site safety procedures and a Job Hazard Analysis (JHA) will be approved through the WTL and WRES safety personnel. All activities will be performed in accordance with the requirements of WP12 FP.01, WP12 IS.01, and WP12 IH.02.

All equipment will be operated in accordance with the appropriate allowable operating pressures and in accordance with the SNL ES&H pressure-safety manual. Pressure ratings for individual parts such as valves and pressure tubing will be either marked by the manufacturer with the maximum allowable operating pressure or such information will be made available in written documentation according to guidelines of the SNL Center 6800 ES&H Coordinator.

Additional and specific safety concerns and requirements to be observed by field personnel will be addressed and documented in the daily safety briefing conducted prior to any field activities. Some of these issues include:

- appropriate use of safety shoes, safety glasses, chemical goggles, hard hats, and protective gloves;
- ensuring adequate fuel is available for all field vehicles, especially those traveling to remote locations;
- proper installation and safety procedures when handling electrical submersible pumps and other electrical equipment;
- proper procedures for operation of diesel-powered generators for on-site electric power;
- proper procedures for inflation of downhole packers;
- familiarity with on- and off-site road conditions and driving regulations;
- familiarity with the locations of first-aid supplies, medical support facilities, and fire extinguishers and other safety equipment;
- familiarity with the location of lists of emergency telephone numbers and persons and offices to notify in the event of emergencies; and
- familiarity with the location of Material Safety Data Sheets.

All field personnel assigned to the field operations described in this TP will receive a safety briefing before the beginning of field operations at each well site. In addition, the WTL or field-site supervisor will conduct daily safety briefings at the beginning of daily operations or at the beginning of each shift. All personnel receiving safety briefings are required to sign and date the safety-briefing form as part of safety-documentation procedures. All work locations will maintain a mobile communication system. In case of accident, injury, or sudden illness, the WIPP Central Monitoring Room (CMR) will be notified immediately. The CMR will coordinate emergency response activities.

7 PERMITTING AND LICENSING

Permitting and licensing requirements are discussed in Subsection 8.3.

8 ROLES AND RESPONSIBILITIES

The work described in this TP will require the drilling of several new wells in the vicinity of the WIPP Site. It will also involve reconditioning several existing wells. Throughout this multiyear field program, wells will be tested, water levels monitored, and well water chemistry will be observed. SNL intends to collaborate with WRES and/or its corporate affiliates to ensure integration of program efforts, to see that this work is done in accordance with all applicable technical and regulatory standards, and that data generated are fully qualified under SNL's WIPP QA program for use in assessing the long-term performance of the repository.

8.1 SNL Responsibilities

SNL's responsibilities are:

- Identify which monitoring wells will need to be reconditioned and work with WRES to identify by what means those wells will be made ready for scientific endeavor.

- Identify which wells will need to be hydraulically tested and identify the type(s) of test(s) to be performed.

- Provide water-level and water-chemistry monitoring equipment, when appropriate, for placement in new (replacement) and/or reconditioned wells.

- Provide all equipment, both downhole and surface, necessary to perform hydraulic tests in new and reconditioned wells.

- Monitor water levels and water chemistry in wells of interest to SNL, or have levels and chemistry monitored.

- Perform all hydraulic tests in wells in collaboration with WRES (Subsection 8.2).

- Analyze and interpret well tests and hydrological monitoring data acquired.

8.2 WRES Responsibilities

WRES will assume the following responsibilities in support of the activities discussed in this TP:

- Recondition (or have reconditioned) any existing wells to be tested.

- For wells to be hydraulically tested, provide (or have provided) the requisite capabilities, including (but not limited to) pump-setting trucks or pulling rigs and crews to install hydraulic testing equipment, “kill” trucks to inflate packers (when required), and appropriately licensed, authorized, and experienced electrician(s) to wire and hook up pumps (as needed).

- Provide necessary oversight personnel at well sites to allow SNL to conduct well-testing operations on a 24-h/day, 7-day/week basis, as needed. In turn, SNL will provide to WRES as much advance notice as possible of the need for specific operations outside normal daytime work hours.

- Dispose of any waste water or other waste materials generated during well testing and well reconditioning operations in accordance with all applicable environmental and regulatory standards (including chemical analysis of produced waste water, as appropriate).

- Facilitate compliance with the applicable WIPP Site environment, health, safety, and security requirements as they relate to program activities.

- Participate in water-level and water-chemistry monitoring and data gathering to the degree that SNL and WRES jointly determine is needed.

8.3 Responsibility for Permitting and Licensing

WRES is responsible for ensuring that WIPP-Site activities are conducted in accordance with applicable federal, state, and local regulatory requirements. WRES is responsible for all permitting and licensing requirements associated with drilling, coring, logging, reconditioning, testing, and waste disposal necessary to complete the activities outlined within this test plan. SNL will abide by all of the permitting and licensing rules and regulatory requirements as indicated by WRES. SNL is responsible for ensuring that all contracted experimental work performed by SNL contractors at the WIPP Site meets all applicable federal, state, and local regulatory requirements.

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